Effects of Mechanical Stresses on the Spinal Cord in Cervical Spondylosis
A Study on Fresh Cadaver Material

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The brain stem and spinal cord, from a mechanical point of view, can be regarded as a single unit, securely fastened above and below. During movement, the cervical cord and its dural covering slide upwards and downwards no more than 2 or 3 mm. within the vertebral canal. Therefore, the cord adopts the length of the spinal canal. When the cervical spinal column is flexed (ventroflexed), the cervical spinal canal elongates and the cord is stretched and lengthened. Extension (dorsiflexion) of the cervical spinal column causes the cord to relax and shorten. Smith demonstrated this in the monkey, Breig and Reid in man. When the neck is flexed, the stretched cord is held against any spondylotic protrusions that may be present. During cervical extension, the flaccid cord deviates according to gravity towards the front or back of the spinal canal, depending on whether the patient is prone or supine (Fig. 1).

The present report describes the deformations of the cervical spinal cord caused by flexion and extension of the neck in subjects with and without spondylosis. Microangiography was used to see how the blood vessels of the spinal cord might be altered and also as the basis of a separate report on the blood supply of the cervical spinal cord. The pathogenesis of the myelopathy of cervical spondylosis is then discussed in relation to these findings.

Materials and Methods

The material consisted of the cervical spines and the contained spinal cord collected from 42 unselected autopsy cases. The first 40 specimens were also used in our preceding report and only additional details concerning their collection, preparation, and examination will be reported here. Cervical air myelograms were done with the neck in the flexed and extended positions to delineate the presence or absence of spondylotic bars.

Following the perfusion with barium suspension and the substitution of formalin for CSF, each cadaver was placed in the cold room overnight with the neck in a flexed, extended, or neutral position (Table 1). Subjects in the flexed and neutral positions were supine; those in the extended position were prone. Positions of flexion or extension were chosen at random in the first 20 subjects. The next 20 cadavers were placed in a position judged to take advantage of any spondylotic bars seen in the air myelograms.

After at least 14 hours fixation, the cervical and upper thoracic cord, with its roots and dural covering, were removed. The existence and size of spondylotic bars was then assessed by inspecting and palpating the anterior wall of the spinal canal after the cord had been removed. Clips were placed on the dura at the level of spondylotic bars observed during removal of the cord.

Microradiographs were made of the whole specimens which were then sectioned and again examined radiologically. When a specimen was indented as a result of contact with a spondylotic ridge during fixation, sections were cut in a serial fashion through the groove. Twenty-six selected sections were then embedded in paraffin, cut thinner, mounted, and stained as histologic slides (haematoxylin and eosin, Gomori’s elastin, and van Gieson’s stains).

The histologic sections and the microradiograms were examined and some were photographed with a microscope. The photographs were used to relate the position of the blood vessels to the outlines of the gray matter and of the whole sections.

The last 2 of the 42 specimens were handled in a different way. After perfusion with the barium suspension, laminectomy was done and the length of the anterior surface of the cervical spinal canal, from the upper border of C1 vertebral body to the lower border of C7, was measured in the positions of maximal flexion and extension. The cords were cut at the levels from which measurements had been made, removed, and x-rayed unfixed. The spinal cords were x-rayed in the shortened and elongated states, with the length of the anterior wall of the cervical spinal canal in maximal extension or flexion. To maintain these lengths, the ends of the specimens were pinned through the film to a board. The x-rays were repeated with the cords in the elongated position stretched over a plastic rod, much as they might have been had they been forced against a spondylotic ridge.

Effects of Cervical Positioning

Extended Position. The cervical spinal cords retained the shape they had acquired during fixation within the cadaver. In the 11 specimens fixed with the neck in dorsal extension, the cervical cord was shortened and its relaxed roots and dentate ligaments undulated as has been described previously.